VARIATION IN THE SONGS OF THE RUFOUS-SIDED TOWHEE

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Considerable variation is known to occur in Rufous-sided Towhee (*Pipilo erythrophthalmus*) songs (Saunders, 1951), but relatively little is known of the exact nature of the variation. This study was made to learn more of the nature of the variation in the songs of this bird.

The collection of tape recordings in the Laboratory for the Study of Animal Sounds, Department of Zoology and Entomology, Ohio State University, includes 71 recordings containing towhee songs (43 from Ohio, 4 from Michigan, 13 from Maine, 2 from West Virginia, 3 from North Carolina, and 6 from Florida); these recordings contain a total of 694 songs (Tables 1 and 7). These songs have been analyzed by means of a Vibralyzer (Borror and Reese, 1953), and graphs made of the different patterns found. Most of the recordings were made by the writer; a few were made by Dr. Carl R. Reese. All the recordings were made with a Magnemite Model 610-E tape recorder, using a tape speed of 15 inches per second.

General Character of Towhee Songs

Towhee songs commonly consist of two parts, (1) one or more introductory notes, and (2) a trill. A few songs lack the first part, a few lack the second part, and a few are double (introductory notes, a trill, then more introductory notes, then another trill). The trill usually consists of a rapid series of similar phrases; occasionally the first note or phrase of the trill is different from the rest, and in rare cases the trill is two-parted (a few phrases of one type, then a few of another type). Each part may vary in the number and character of the notes or phrases it contains.

A towhee generally sings at the rate of five to ten songs a minute. Its songs are usually all alike, but it may occasionally sing songs of one type for a while, and then change to a different type; rarely a bird may sing two types of songs alternately. The largest number of song types recorded from a single bird in a single recording was eight (recording No. 879B, from Florida).

Variation in Introductory Notes of Song

The introductory notes in the songs studied represented 45 different patterns (plus one other in which there were *no* introductory notes). These patterns were designated by capital letters, A through TT, and may be classified as follows:

I. With no introductory notes (designated as pattern A)

II. With one introductory note (12 patterns, B–M)
   a. The note clear and musical (5 patterns, B–F, Figs. 1, 9–12, and one note like those in Fig. 46)
   b. The note buzzy (5 patterns, G–K, Figs. 2, 13–17)
   c. The note with both musical and buzzy elements (2 patterns, L–M, Figs. 18–19)

III. With two introductory notes (23 patterns, N–JJ)
   a. The two notes about the same pitch (5 patterns, N–R, Figs. 3, 20–22, and two notes like those in Fig. 46)
   b. The first note higher in pitch than the second (12 patterns, S–DD, Figs. 4–6, 23–39)
   c. The second note higher in pitch than the first (6 patterns, EE–JJ, Figs. 7, 40–45)

IV. With three introductory notes (8 patterns, KK–RR)
   a. The three notes alike (1 pattern, KK, Fig. 46)
   b. The first two notes alike, the third different (2 patterns, LL–MM, Figs. 47–48)
   c. All three notes different (5 patterns, NN–RR, Figs. 8, 49–53)

V. With four introductory notes (2 patterns, SS–TT)
   a. The four notes alike (1 pattern, SS, the notes like those in Fig. 46)
   b. The four notes different (1 pattern, TT, Fig. 54)

The occurrence of these introductory patterns in the recordings from different areas is summarized in Table 2.

One Introductory Note.—Nearly one-fourth of the introductory patterns found consisted of a single note. When this note was musical, it was steady in pitch (Figs. 1, 9, and 10), slightly up-slurred (Fig. 11), abruptly down-slurred (like the notes in Fig. 46), or down-slurred at the beginning and then steady in pitch (Fig. 12). When it was buzzy, it was up-slurred (resembling the "chewink" call, Figs. 2, 15), or steady in pitch (Figs. 14, 16, and 17). The introductory note in one Ohio pattern (pattern L) was buzzy at the beginning, then musical and nearly steady in pitch (Fig. 18); in one Florida pattern (pattern M) it was abruptly down-slurred and then buzzy (Fig. 19).

Two Introductory Notes.—Half of the introductory patterns found consisted of two notes. These notes were alike in four patterns (2 from Florida, 1 from Maine, and 1 from central Ohio, Figs. 3, 21, 22, and like two of the notes in Fig. 46), and slightly different in quality but of about the same pitch in one Florida pattern (Fig. 20). The most common type of introduction (12 patterns) consisted of a high-pitched note and a lower-pitched note; in most of these (Figs. 4, 23–32) the first note was shorter and sharper than the second, with the second musical; in a few cases (Figs. 5, 33, and 34) the first note was buzzy; in a few other cases (Figs. 36–39) the first note was complex, containing two dominant frequencies or containing two or more overlapping notes; in one pattern (Figs. 6, 35) the two introductory notes overlapped.

Three or Four Introductory Notes.—These patterns made up a little over one-fifth of the total. Most of the introductory patterns consisting of three notes (Figs. 8, 49–53) had these notes different.

Twelve of the introductory patterns (excluding pattern A, representing no introductory notes) occurred in the songs of different birds; the occurrence of these patterns is summarized in Table 3. One pattern (V, Figs. 27–29) occurred in as many as seven different birds; several patterns occurred in birds from widely separated areas.

TABLE 1

RUFOUS-SIDED TOWHEE SONG RECORDINGS STUDIED

Recording					Figure No.[2]		
No.	Locality	Date	Series[1]	Song Pattern	Introd.	Trill	No. of Songs
342	Bradenton, Florida	March 24, 1953	—	FF-31	41	83	5
384	Franklin Co., Ohio	April 10, 1953	A	F-22	(12)	(75)	3
			B	NN-33	49	(85)	2
432	Columbus, Ohio	April 29, 1953	—	OO-46	50	99	9
457	Reynoldsburg, Ohio	May 4, 1953	—	OO-37	8	8	7
665	Worthington, Ohio	May 30, 1953	—	II-44	44	97	10
762	Reynoldsburg, Ohio	March 24, 1954	A	C-39	(10)	92	10
			B	C-47	(10)	101	1
766	Reynoldsburg, Ohio	March 24, 1954	—	C-18	1	1	11
786R	Columbus, Ohio	April 21, 1954	—	V-38	(27)	91	9
814B	Bradenton, Florida	April 6, 1954	A	Q-1	(3)	—	1
			B	Q-4	3	3	21
879B	Myakka River State Park, Florida	April 13, 1954	A	A-27	—	80	5
			B	E-27	(46)[3]	(80)	1
			C	O-27	(46)[3]	(80)	5
			D	KK-27	(46)	(80)	1
			E	N-6	20	(59)	1
			F	M-6	19	59	11
			G	KK-1	46	—	3
			H	SS-1	(46)[3]	—	1
912B	Greensboro, N. C.	April 24, 1954	—	PP-15	51	68	8
916B	Greensboro, N. C.	April 24, 1954	A	Y-1	(33)	—	1
			B	Y-28	33	81	11
921B	Greensboro, N. C.	April 24, 1954	—	GG-5	42	57	10
1127	Hocking Co., Ohio	June 5, 1954	—	G-47	13	(103)	8
1262	New Albany, Ohio	April 1, 1955	—	MM-23	48	76	11
1284	New Albany, Ohio	April 10, 1955	A	F-21	12	74	2
			B	U-47	26	(102)	7
1296	Columbus, Ohio	April 13, 1955	—	HH-49	(43)	107	6
1299	Columbus, Ohio	April 14, 1955	A	U-32	25	84	9
			B	U-8	(25)	61	8
1433	Worthington, Ohio	May 19, 1955	—	II-49	(44)	(107)	9
1464	Adams Co., Ohio	May 30, 1955	—	HH-49	7	7	15
1471	Hocking Co., Ohio	June 5, 1955	A	L-1	18	—	3
			B	A-12-2	—	65, 55	3
1550B	Lincoln Co., Maine	July 19, 1955	—	C-26	(10)	79	8
1557B	Lincoln Co., Maine	July 23, 1955	A	W-34	(31)	86	3
			B	W-43	(31)	96	10

TABLE 1 (*Continued*)

Recording					Figure No.[2]		
No.	Locality	Date	Series[1]	Song Pattern	Introd.	Trill	No. of Songs
1560B	Lincoln Co., Maine	July 23, 1955	—	B-34	(9)	(86)	11
1641B	Bradenton, Florida	March 14, 1956	—	Z-3	34	56	1
1649	New Albany, Ohio	March 27, 1956	A	LL-24	47	77	6
			B	OO-29	(50)	82	10
1728	Reynoldsburg, Ohio	April 28, 1956	A	F-1	(12)	—	1
			B	F-47	(12)	105	7
1731	Reynoldsburg, Ohio	April 28, 1956	A	JJ-1	(45)	—	11
			B	JJ-47	45	(103)	2
1734	Reynoldsburg, Ohio	April 28, 1956	—	DD-36	38	90	11
1786	New Albany, Ohio	May 5, 1956	A	U-24	(25)	(4)	2
			B	T-47	24	102	2
1808	Reynoldsburg, Ohio	May 6, 1956	—	U-24	4	4	11
1823	New Albany, Ohio	May 9, 1956	A	A-46	—	(100)	5
			B	A-46-46	—	(100)	10
1826	New Albany, Ohio	May 9, 1956	—	EE-14	40	67	6
1955	Reynoldsburg, Ohio	May 30, 1956	—	C-18	(10)	(71)	11
1958	Reynoldsburg, Ohio	May 30, 1956	—	CC-35	37	88	7
1971	Adams Co., Ohio	June 2, 1956	A	F-28	(12)	(81)	2
			B	F-22	(12)	75	1
1991	Hocking Co., Ohio	June 2, 1956	—	U-24	(25)	(77)	8
2109	Lincoln Co., Maine	July 1, 1956	—	W-34	30	(86)	11
2112	Lincoln Co., Maine	July 1, 1956	—	C-7	(10)	(60)	3
2205	Lincoln Co., Maine	July 19, 1956	—	C-7	(10)	60	12
2207	Lincoln Co., Maine	July 19, 1956	A	TT-16	54	69	4
			B	QQ-16	52	(69)	2
2213	Lincoln Co., Maine	July 25, 1956	A	V-30	(28)	(2)	5
			B	I-11	(2)	64	2
			C	I-30	2	2	3
2215	Lincoln Co., Maine	July 25, 1956	A	C-20	(10)	73	13
			B	X-34	5	5	2
			C	A-34	—	(5)	1
			D	C-34	10	(5)	2
2357	Collier Co., Florida	March 21, 1957	—	J-41	(16)	(94)	8
2390	Collier Co., Florida	March 21, 1957	—	J-41	16	94	6
2445	New Albany, Ohio	April 11, 1957	—	HH-50	(43)	110	5
2457	New Albany, Ohio	April 16, 1957	—	F-50	(12)	111	10

TABLE 1 (*Continued*)

Recording			Series[1]	Song Pattern	Figure No.[2]		No. of Songs
No.	Locality	Date			Introd.	Trill	
2458	New Albany, Ohio	April 16, 1957	—	F-50	(12)	(111)	9
2459	New Albany, Ohio	April 16,1957	A	HH-50	(43)	(112)	7
			B	HH-49	(43)	108	2
2460	New Albany, Ohio	April 16, 1957	—	AA-47	6	6	8
2463	New Albany, Ohio	April 16, 1957	—	DD-5	39	58	9
2476	New Albany, Ohio	April 24, 1957	A	B-18	9	(71)	12
			B	P-51	21	113	2
2486	New Albany, Ohio	April 27, 1957	—	H-18	14	71	13
2488	New Albany, Ohio	April 27, 1957	—	AA-47	(6)	104	10
2489	New Albany, Ohio	April 27, 1957	—	V-53	28	115	5
2497	New Albany, Ohio	April 27, 1957	—	HH-50	43	112	14
2499	Reynoldsburg, Ohio	April 28, 1957	—	D-42	11	95	8
2520	Whitehall, Ohio	May 1, 1957	—	U-25	(25)	78	11
2578	Reynoldsburg, Ohio	May 7, 1957	—	V-19	29	72	8
2587	Columbus, Ohio	May 10, 1957	A	AA-47	35	103	7
			B	B-46	(9)	100	11
			C	I-48	15	106	9
2666	Worthington, Ohio	May 18, 1957	—	RR-35	53	89	2
2706	Kanawha City, W. Va.	May 25, 1957	—	S-33	23	85	6
2715	Kanawha City, W. Va.	May 25, 1957	A	C-9	(10)	62	3
			B	C-9-H-17	(10, 14)	(62), 70	4
2757	Oscoda Co., Mich.	May 30, 1957	A	BB-1	(36)	—	2
			B	BB-13	36	66	5
2770	Oscoda Co., Mich.	May 31, 1957	—	V-52	27	114	6
2781	Oscoda Co., Mich.	May 31, 1957	—	V-45	(27)	98	12
2782	Oscoda Co., Mich.	May 31, 1957	—	K-54	17	116	7
2941	Lincoln Co., Maine	July 3, 1957	—	W-50	31	109	10
2945	Lincoln Co., Maine	July 13, 1957	—	W-10	(31)	63	10
3000	Lincoln Co., Maine	July 14, 1957	—	V-34	(28)	(86)	12
3002	Lincoln Co., Maine	July 14, 1957	A	R-34	22	87	3
			B	W-40	32	93	4
			C	W-1	(32)	—	1

[1] Series are designated only in recordings containing songs of two or more patterns.
[2] Numbers in parentheses represent figures of this pattern, but were made from a song in another series.
[3] Patterns E, O, and SS are like pattern KK (Fig. 46), but contain one, two, and four notes respectively, instead of three.

Table 2

Occurrence of the Introductory Patterns in Towhee Songs

Pattern Group[1]	Number of Patterns							
	Central Ohio	Southern Ohio	Michigan	Maine	West Virginia	North Carolina	Florida	Total[2]
I	1	1		1			1	1
II a	4	1		2	1		1	5
II b	2	1	1	1	1		1	5
II c		1					1	2
III a	1			1			3	5
III b	6	1	2	3	1	1	1	12
III c	4	1				1	1	6
IV a							1	1
IV b	2							2
IV c	3			1		1		5
V a							1	1
V b				1				1
Total[3]	23	6	3	10	3	3	11	46

[1] Roman numerals and small letters refer to the groups in the classification outlined on p. 55.
[2] Some patterns occur in the songs of birds from different areas.
[3] Includes the pattern of **no** introductory notes.

Table 3

Introductory Patterns Occurring in the Songs of More Than One Bird

Pattern and Group[1]	Number of Birds in Which the Pattern Occurred							
	Central Ohio	Southern Ohio	Michigan	Maine	West Virginia	North Carolina	Florida	Total
II a B	2			1				3
II a C	2			3	1			6
II a F	3	1						4
II b H	1				1			2
II b I	1			1				2
III b U	4	1						5
III b V	3		2	2				7
III b W				3				3
III b DD	2							2
III c HH	3	1						4
III c II	2							2
IV c OO	3							3

[1] Roman numerals and small letters refer to the groups in the classification outlined on p. 55; the capital letters refer to individual introductory patterns.

Variations in the Trill

The songs studied contained 53 different trill patterns (designated by numbers, 1–54, with No. 1 representing no trill); there was more variation in the trill than in the introductory part of the song. Even in the songs of different birds considered to have trills of the same pattern, there were minor variations (compare Figs. 5, 86, and 87; 101–105; 107 and 108; and 109–112) in the trill.

The different trill patterns differed in the general character of the phrases (number and types of notes present), their length (or the rate with which they were uttered), their number, and in how the trill began. The first phrase of the trill in 23 of the patterns was different from the remaining phrases, that is, the trill began with an extra note (Figs. 2, 4, 8, 60–63, 65, 66, 68, 75–79, 81, 82, 91, 93, 96, 99–101, 115, and 116); this note was sometimes very short (0.05 sec. or shorter), but in most cases it was longer than any of the subsequent trill phrases, and higher in pitch.

The variations in the trill were such that the different trill patterns were not readily classifiable. The phrases contained from one to several notes, and the notes frequently overlapped. Some of the characteristics of the trill patterns occurring in the songs of birds from different areas are summarized in Table 4. Songs of a given type sung by a given bird occasionally differed by one or a few phrases in the number of phrases in the trill; these differences were not considered to represent different trill patterns. Songs containing different types of trills often differed considerably in the number of trill phrases they contained, and in the rate with which the phrases were uttered.

Table 4

Summary of Trill Characteristics

Area	No. of Song Series	No. of Trills[1]	Trill Phrase Length (in seconds)		Number of Trill Phrases		
						Series Averages	
			Range	Average[2]	Range	Range	Average[2]
Central Ohio	48	375	.05–.20	.095±.004	2–15	2.78–14.32	7.36±0.34
Southern Ohio	7	38	.05–.12	.081±.012	2–10	3.33–10.00	6.29±0.85
Michigan	4	30	.11–.13	.120±.004	2–6	2.80–5.86	4.69±0.66
Maine	21	143	.03–.13	.072±.006	4–18	4.00–17.42	9.41±0.90
West Virginia	4	17	.06–.12	.088±.016	4–7	5.00–7.00	5.80±0.45
North Carolina	3	29	.04–.08	.063±.012	8–16	8.91–15.38	11.61±1.94
Florida	9	65	.05–.17	.092±.012	3–14	3.00–9.90	7.83±0.74
Total	96	697	.03–.20	.088±.003	2–18	2.78–17.42	7.73±0.31

[1] This is not quite the same as the number of songs, since some songs had no trill and some had two trills.

[2] Averages are given plus or minus the standard error of the mean; the figures in the last column are averages of the series averages.

The trill phrases varied in length from 0.03 (pattern 10, Fig. 63) to 0.20 sec. (pattern 48, Fig. 106), and were uttered at rates from 5 to about 35 phrases per second; they varied in number from 2 to 18. The trill phrases in the songs of Michigan birds averaged significantly longer than in birds from Ohio, Maine, and North Carolina; those in the songs of central Ohio birds averaged significantly longer than in birds from Maine. The number of trill phrases averaged significantly greater in the songs of birds from Maine than in the birds from Michigan and West Virginia, greater in the birds from North Carolina than in those from Michigan and West Virginia, and greater in the birds from central Ohio than in those from Michigan. In general, the shorter the trill phrases, the more phrases there were.

The trill phrases were generally all of the same pitch; rarely the pitch appeared to fall a little toward the end of the trill, usually because of the dropping out of some of the higher frequencies. The last phrase of the trill was occasionally incomplete. The trill often became less loud toward the end. When the trill began with a high-pitched buzz (for example, pattern 24, Fig. 4), this buzz was much louder than the rest of the trill.

Twelve trill patterns (excluding pattern 1, representing no trill) occurred in the songs of different birds (Table 5). Most of these recurring patterns occurred in only two or three birds; one (No. 47, Figs. 6, 101–105) occurred in six birds. Many of these patterns occurred in the songs of birds in widely separated areas.

TABLE 5

TRILL PATTERNS OCCURRING IN THE SONGS OF MORE THAN ONE BIRD

Trill Pattern	Number of Birds in Which the Pattern Occurred							
	Central Ohio	Southern Ohio	Michigan	Maine	West Virginia	North Carolina	Florida	Total
5	1					1		2
18	3							3
22	1	1						2
24	2	1						3
28		1				1		2
33	1				1			2
34				2				2
35	2							2
46	3							3
47	5	1						6
49	3	1						4
50	2			1				3

Song Patterns

The combination of a particular type of introduction (A to TT) and trill (1 to 54) resulted in a particular song pattern (for example, B-18, K-54, and SS-1). A total of 93 song patterns were found in the recordings studied. These patterns are most easily classified on the basis of the type of introduction they contained. The occurrence of the 93 patterns in the songs of birds in different areas is summarized in Table 6.

Although there were 12 introductory patterns and 12 trill patterns that occurred in the songs of different birds, there were only 5 *song* patterns that were sung by different birds:

(1) Pattern F-22, sung by a bird in central Ohio (recording 384, series A) and another in southern Ohio (recording 1971, series B).

(2) Pattern U-24, sung by two birds in central Ohio (recording 1786, series A, and recording 1808, Reynoldsburg) and one in southern Ohio (recording 1991).

(3) Pattern AA-47, sung by two birds in central Ohio (recording 2460, and recording 2587, series A).

(4) Pattern HH-49, sung by two birds in central Ohio (recording 1296, Columbus, and recording 2459, series B, New Albany) and another in southern Ohio (recording 1464).

(5) Pattern HH-50, sung by two birds in central Ohio[1] (recordings 2459, series A, and 2497, and recording 2445).

There is a great deal of difference in the song pattern of different birds, and only rarely (in this study, only 5 of 93 song patterns) does one find a given song pattern sung by different birds. When the song patterns of different birds are sufficiently different to be distinguishable by ear, the individual birds can be recognized by their songs.

The songs of the Florida birds were somewhat different in character from those of the northern birds; none of the introductory or trill patterns of the Florida birds (except those of *no* introduction or trill) occurred in the songs of any northern birds (Tables 3 and 5). Most songs of the Florida birds are readily distinguishable by ear from those of northern birds.

There was an appreciable time interval between the notes of the introduction (when the introduction contained more than one note), and between the introduction and the trill. The time interval between the notes of the introduction is shown by the graphs (Figs. 3–8 and 20–54). The interval between the introduction and the trill (shown only in Figs. 1–8) varied in the different patterns from 0.04 to 0.30 sec., and averaged 0.12 sec.

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[1] There is a slight possibility that these recordings were of the same bird. Recordings 2459 and 2497 were made about fifty yards (and eleven days) apart; 2445 was made about one-fourth mile away, and five days before the first of the other two recordings was made.

TABLE 6

OCCURRENCE OF TOWHEE SONG PATTERNS

Pattern[2]		Number and Per Cent of Song Patterns[1]							
		Central Ohio	Southern Ohio	Michigan	Maine	West Virginia	North Carolina	Florida	Total
I		2 4.65	1 14.29		1 5.00			1 7.14	5 5.38
II	a	11 25.58	2 28.57		5 25.00	2 66.67		1 7.14	20[3] 21.51
	b	2 4.65	1 14.29	1 20.00	2 10.00			1 7.14	7 7.53
	c		1 14.29					1 7.14	2 2.15
	Tot.	13 30.23	4 57.14	1 20.00	7 35.00	2 66.67		3 21.43	29[3] 31.18
III	a	1 2.33			1 5.00			5 35.71	7 7.53
	b	13 30.23	1 14.29	4 80.00	9 45.00	1 33.33	2 50.00	1 7.14	30[3] 32.26
	c	7 16.28	1 14.29				1 25.00	1 7.14	9[3] 9.68
	Tot.	21 48.84	2 28.57	4 80.00	10 50.00	1 33.33	3 75.00	7 50.00	46[4] 49.46
IV	a							2 14.29	2 2.15
	b	2 4.65							2 2.15
	c	5 11.63			1 5.00		1 25.00		7 7.53
	Tot.	7 16.28			1 5.00		1 25.00	2 14.29	11 11.83
V	a							1 7.14	1 1.07
	b				1 5.00				1 1.07
	Tot.				1 5.00			1 7.14	2 2.15
Total		43 46.24	7 7.53	5 5.38	20 21.51	3 3.22	4 4.30	14 15.05	93[5]

[1] The upper figure is the number of song patterns, and the lower figure is the per cent of the patterns from that area; in the bottom line, under "Total," the per cent is the per cent of all the patterns (93) occurring in the songs of birds from that area.
[2] Roman numerals and small letters refer to the groups in the classification outlined on p. 55.
[3] One of these patterns occurred in the songs of birds from two different areas.
[4] Two of these patterns occurred in the songs of birds from two different areas.
[5] Three of these patterns occurred in the songs of birds from two different areas.

The frequencies in the towhee songs studied (excluding harmonics) were for the most part between 2000 and 6000 cycles per second. The extremes found were 1800 cycles per second (patterns DD and MM, Figs. 39 and 48) and 9000 cycles per second (pattern 36, Fig. 90).

Table 7

Summary of the Towhee Recordings Studied

Number of	Central Ohio	Southern Ohio	Michigan	Maine	West Virginia	North Carolina	Florida	Total
Birds Recorded[1]	27	5	2	7	2	3	5	51
Recordings	38	5	4	13	2	3	6	71
Song Series[2]	51	7	5	22	3	4	14	106
Songs	377	40	32	132	13	30	70	694
Introductory Patterns[3]	22	5	3	9	3	3	10	45[4]
Trill Patterns[3]	27	7	4	11	3	3	6	53[4]
Song Patterns[3]	43	8	5	20	3	4	14	93

[1] An estimate; represents a minimum figure.
[2] A song series is a group of songs of a given pattern in a given recording.
[3] Some of these patterns occurred in the songs of birds from more than one area.
[4] Does not include the pattern of **no** introduction or trill.

Summary

The songs of the Rufous-sided Towhee usually consist of one or more introductory notes and a trill. In 71 tape recordings of towhee songs, from six states (Ohio, Michigan, Maine, West Virginia, North Carolina, and Florida) and containing 694 songs, there were 45 introductory patterns (plus one of *no* introductory notes) and 53 trill patterns (plus one of *no* trill). The introductory patterns contained from one to four notes. The trills contained from 2 to 18 phrases, uttered at rates f 5 to 35 phrases per second. The different introductory and trill patterns were combined in 93 different song patterns (Table 7). The recordings were studied by means of a Vibralyzer. The song patterns were classified on the basis of their introductory notes. Twelve introductory patterns and 12 trill patterns, but only 5 song patterns, were found in the songs of different birds. The frequencies in the songs ranged from 1800 to 90000 cycles per second, but in most songs were between 2000 and 6000 cycles per second.

There is a great deal of variation in towhee songs, and more variation in the trill than in the introductory notes. It is possible in many cases to recognize individual birds by their song.

Plate 1. Audiospectrographs of Towhee Songs. Fig. 1, pattern C-18, 766-1, central Ohio. Fig. 2, pattern I-30, 2213-4 (C), Maine. Fig. 3, pattern Q-4, 814B-7 (B), Florida. Fig. 4, pattern U-24, 1808-2, central Ohio. Fig. 5, pattern X-34, 2215-4 (B), Maine. Fig. 6, pattern AA-47, 2460-1, central Ohio. Fig. 7, pattern HH-49, 1464-1, southern Ohio. Fig. 8, pattern OO-37, 457-1, central Ohio. Numbers following the pattern represent the recording, and the song in the recording, from which the graph was made; letters in parentheses represent the series in the recording.

Plate 2. Audiospectrographs of Introductory Patterns in Towhee Songs. Fig. 9, pattern B, 2476-1 (A), central Ohio. Fig. 10, pattern C, 2215-8 (D), Maine. Fig. 11, pattern D, 2499-1, central Ohio. Fig. 12, pattern F, 1284-1 (A), central Ohio. Fig. 13, pattern G, 1127-2, southern Ohio. Fig. 14, pattern H, 2486-1, central Ohio. Fig. 15, pattern I, 2587-21 (C), central Ohio. Fig. 16, pattern J, 2390-1, Florida. Fig. 17, pattern K, 2782-1, Michigan. Fig.

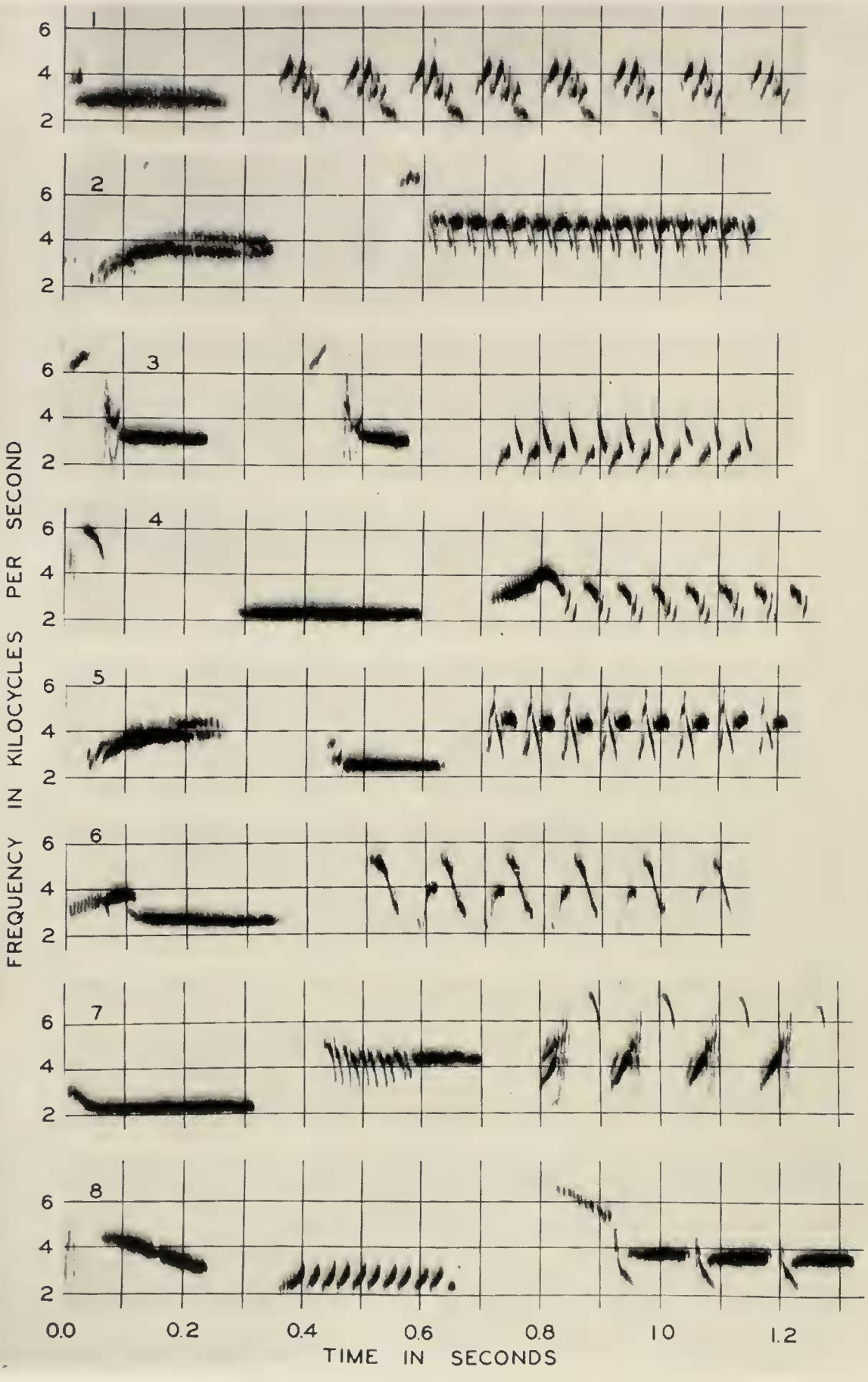
18, pattern L, 1471-1 (A), southern Ohio. Fig. 19, pattern M, 879B-6 (F), Florida. Fig. 20, pattern N, 879B-5 (E), Florida. Fig. 21, pattern P, 2476-2 (B), central Ohio. Fig. 22, pattern R, 3002-2 (A), Maine. Fig. 23, pattern S, 2706-2, West Virginia. Fig. 24, pattern T, 1786-2 (B), central Ohio. Fig. 25, pattern U, 1299-1 (A), central Ohio. Fig. 26, pattern U, 1284-4 (B), central Ohio. Fig. 27, pattern V, 2770-1, Michigan. Fig. 28, pattern V, 2489-1, central Ohio. Fig. 29, pattern V, 2578-4, central Ohio. The recording, song, and series from which each graph was made are indicated as in Plate 1.

Plate 3. Audiospectrographs of Introductory Patterns in Towhee Songs. Fig. 30, pattern W, 2109-1, Maine. Fig. 31, pattern W, 2941-1, Maine. Fig. 32, pattern W, 3002-5 (B), Maine. Fig. 33, pattern Y, 916B-1 (B), North Carolina. Fig. 34, pattern Z, 1641B-1, Florida. Fig. 35, pattern AA, 2587-1 (A), central Ohio. Fig. 36, pattern BB, 2757-1 (B), Michigan. Fig. 37, pattern CC, 1958-2, central Ohio. Fig. 38, pattern DD, 1734-1, central Ohio. Fig. 39, pattern DD, 2463-2, central Ohio. Fig. 40, pattern EE, 1826-1, central Ohio. Fig. 41, pattern FF, 342-3, Florida. Fig. 42, pattern GG, 921B-1, North Carolina. Fig. 43, pattern HH, 2497-1, central Ohio. The recording, song, and series from which each graph was made are indicated as in Plate 1.

Plate 4. Audiospectrographs of Introductory Patterns in Towhee Songs. Fig. 44, pattern II, 665-2, central Ohio. Fig. 45, pattern JJ, 1731-4 (B), central Ohio. Fig. 46, pattern KK, 879B-27 (G), Florida. Fig. 47, pattern LL, 1649-2 (A), central Ohio. Fig. 48, pattern MM, 1262-1, central Ohio. Fig. 49, pattern NN, 384-4 (B), central Ohio. Fig. 50, pattern OO, 432-2, central Ohio. Fig. 51, pattern PP, 912B-4, North Carolina. Fig. 52, pattern QQ, 2207-2 (B), Maine. Fig. 53, pattern RR, 2666-1, central Ohio. Fig. 54, pattern TT, 2207-1 (A), Maine. The recording, song, and series from which each graph was made are indicated as in Plate 1.

Plate 5. Audiospectrographs of Trill Patterns in Towhee Songs (only the first part of each trill is shown; the remaining phrases in each case are like the ones shown). Fig. 55, pattern 2, 1471-4 (B), southern Ohio. Fig. 56, pattern 3, 1641B-1, Florida. Fig. 57, pattern 5, 921B-2, North Carolina. Fig. 58, pattern 5, 2463-2, central Ohio. Fig. 59, pattern 6, 879B-6 (F), Florida. Fig. 60, pattern 7, 2205-1, Maine. Fig. 61, pattern 8, 1299-7 (B), central Ohio. Fig. 62, pattern 9, 2715-2 (A), West Virginia. Fig. 63, pattern 10, 2945-5, Maine. Fig. 64, pattern 11, 2213-2 (B), Maine. Fig. 65, pattern 12, 1471-4 (B), southern Ohio. Fig. 66, pattern 13, 2757-1 (B), Michigan. Fig. 67, pattern 14, 1826-1, central Ohio. Fig. 68, pattern 15, 912B-4, North Carolina. Fig. 69, pattern 16, 2207-1 (A), Maine. Fig. 70, pattern 17, 2715-3 (B), West Virginia. Fig. 71, pattern 18, 2486-1, central Ohio. Fig. 72, pattern 19, 2578-4, central Ohio. Fig. 73, pattern 20, 2215-1 (A), Maine. Fig. 74, pattern 21, 1284-1 (A), central Ohio. Fig. 75, pattern 22, 1971-2 (B), southern Ohio. Fig. 76, pattern 23, 1262-1, central Ohio. Fig. 77, pattern 24, 1649-2 (A), central Ohio. Fig. 78, pattern 25, 2520-2, central Ohio. Fig. 79, pattern 26, 1550B-1, Maine. Fig. 80, pattern 27, 879B-1 (A), Florida. Fig. 81, pattern 28, 916B-1 (B), North Carolina. Fig. 82, pattern 29, 1649-7 (B), central Ohio. Fig. 83, pattern 31, 342-3, Florida. Fig. 84, pattern 32, 1299-1 (A), central Ohio. Fig. 85, pattern 33, 2706-1, West Virginia. Fig. 86, pattern 34, 1557B-1 (A), Maine. Fig. 87, pattern 34, 3002-2 (A), Maine. Fig. 88, pattern 35, 1958-2, central Ohio. The recording, song, and series from which each graph was made are indicated as in Plate 1.

Plate 6. Audiospectrographs of Trill Patterns in Towhee Songs (only the first part of each trill is shown; the remaining phrases in each case are like the ones shown). Fig. 89, pattern 35, 2666-1, central Ohio. Fig. 90, pattern 36, 1734-1, central Ohio. Fig. 91, pattern 38, 786R-5, central Ohio. Fig. 92, pattern 39, 762-3 (A), central Ohio. Fig. 93, pattern 40, 3002-5 (B), Maine. Fig. 94, pattern 41, 2390-1, Florida. Fig. 95, pattern 42, 2499-1, central Ohio. Fig. 96, pattern 43, 1557B-6 (B), Maine. Fig. 97, pattern 44, 665-2, central Ohio. Fig. 98, pattern 45, 2781-1, Michigan. Fig. 99, pattern 46, 432-2, central Ohio. Fig. 100, pattern 46, 2587-8 (B), central Ohio. Fig. 101, pattern 47, 762-6 (B), central Ohio. Fig. 102, pattern 47, 1786-2 (B), central Ohio. Fig. 103, pattern 47, 2587-1 (A), central Ohio. Fig. 104, pattern 47, 2488-1, central Ohio. Fig. 105, pattern 47, 1728-1 (B), central Ohio. Fig. 106, pattern 48, 2587-21 (C), central Ohio. Fig. 107, pattern 49, 1296-1, central Ohio. Fig. 108, pattern 49, 2459-7 (B), central Ohio. Fig. 109, pattern 50, 2941-1, Maine. Fig. 110, pattern 50, 2445-1, central Ohio. Fig. 111, pattern 50, 2457-1, central Ohio. Fig. 112, pattern 50, 2497-1, central Ohio. Fig. 113, pattern 51, 2476-2 (B), central Ohio. Fig. 114, pattern 52, 2770-1, Michigan. Fig. 115, pattern 53, 2489-1, central Ohio. Fig. 116, pattern 54, 2782-1, Michigan. The recording, song, and series from which each graph was made are indicated as in Plate 1.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FREQUENCY IN KILOCYCLES PER SECOND
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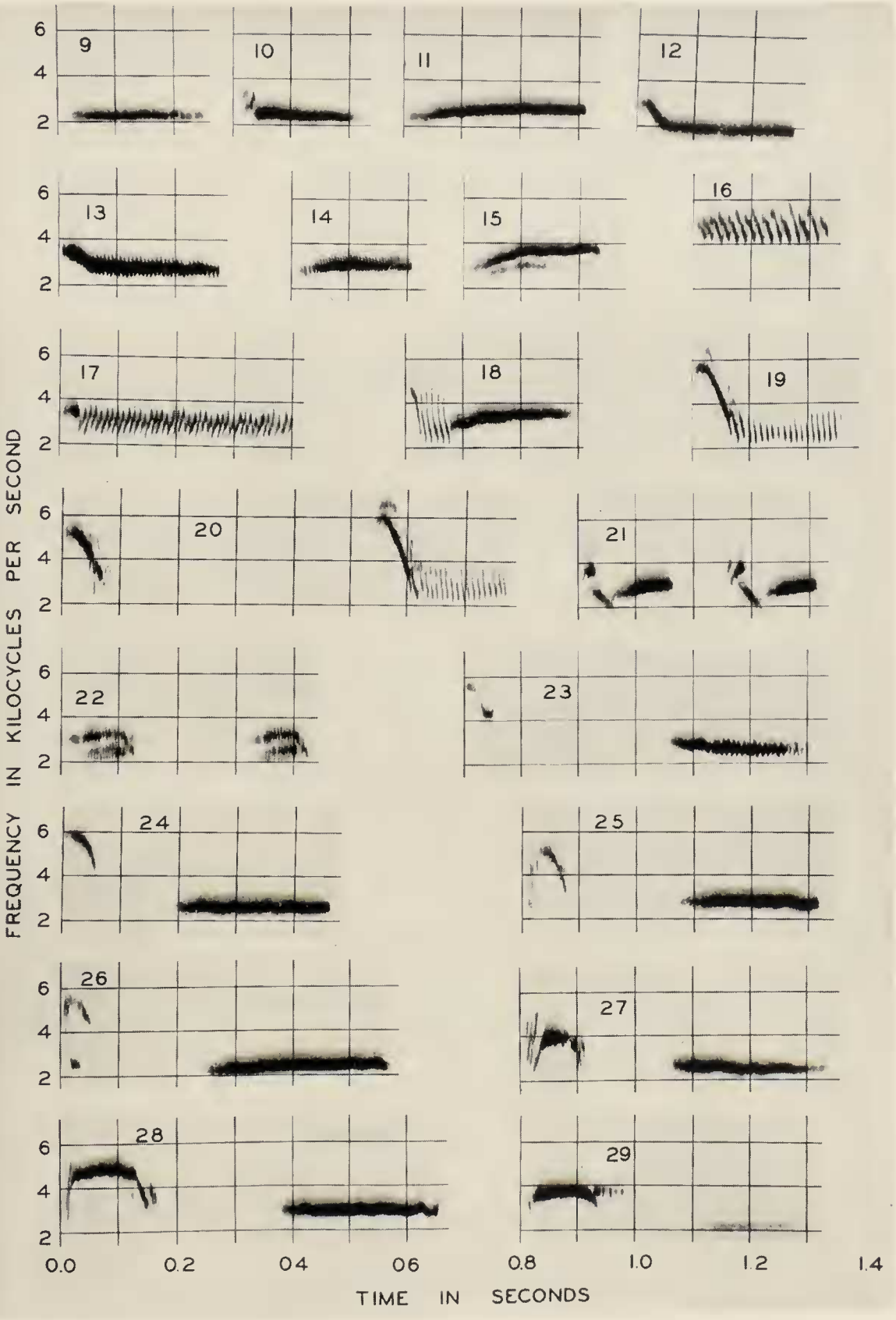
TIME IN SECONDS

PLATE 1.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FREQUENCY IN KILOCYCLES PER SECOND
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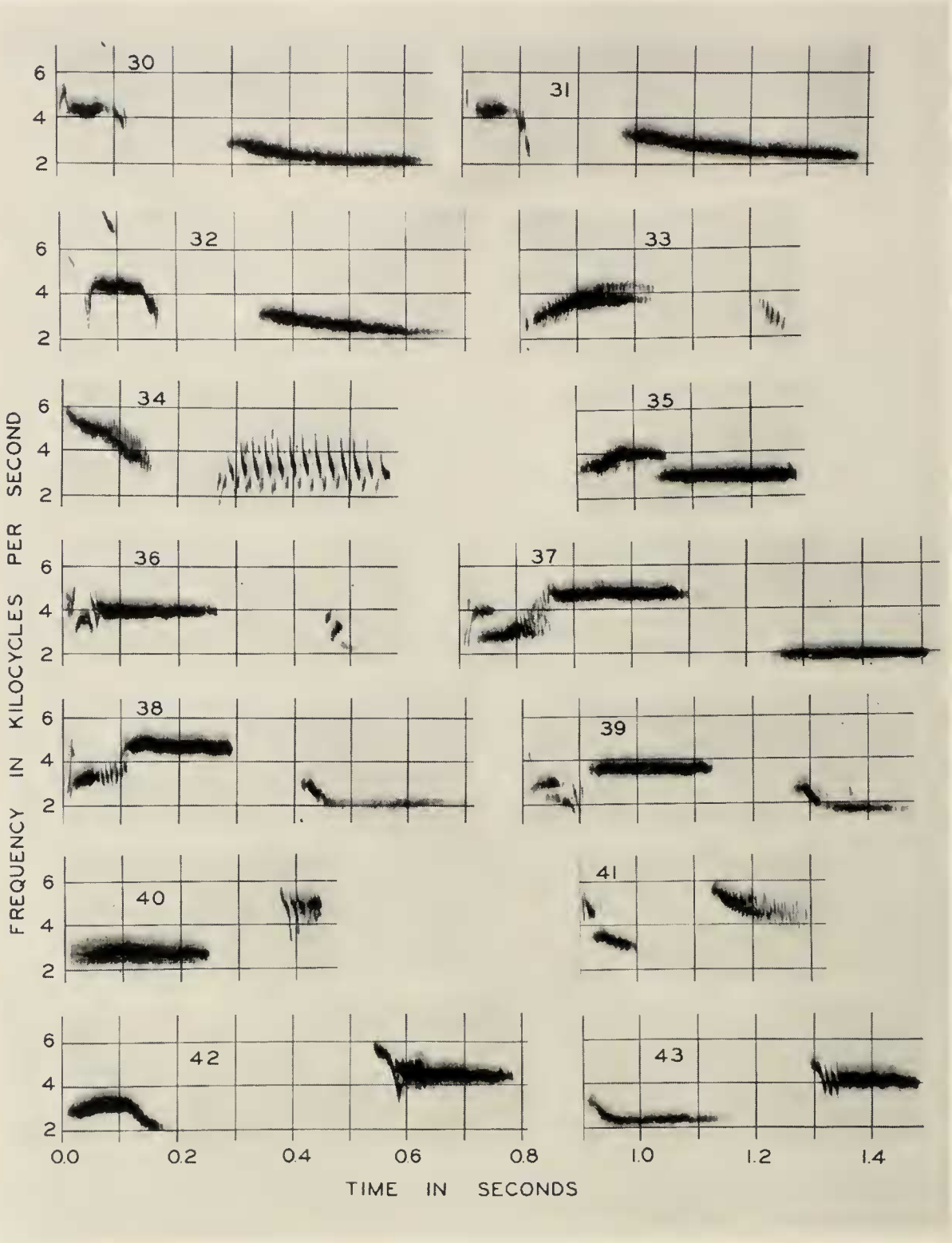
TIME IN SECONDS

PLATE 2.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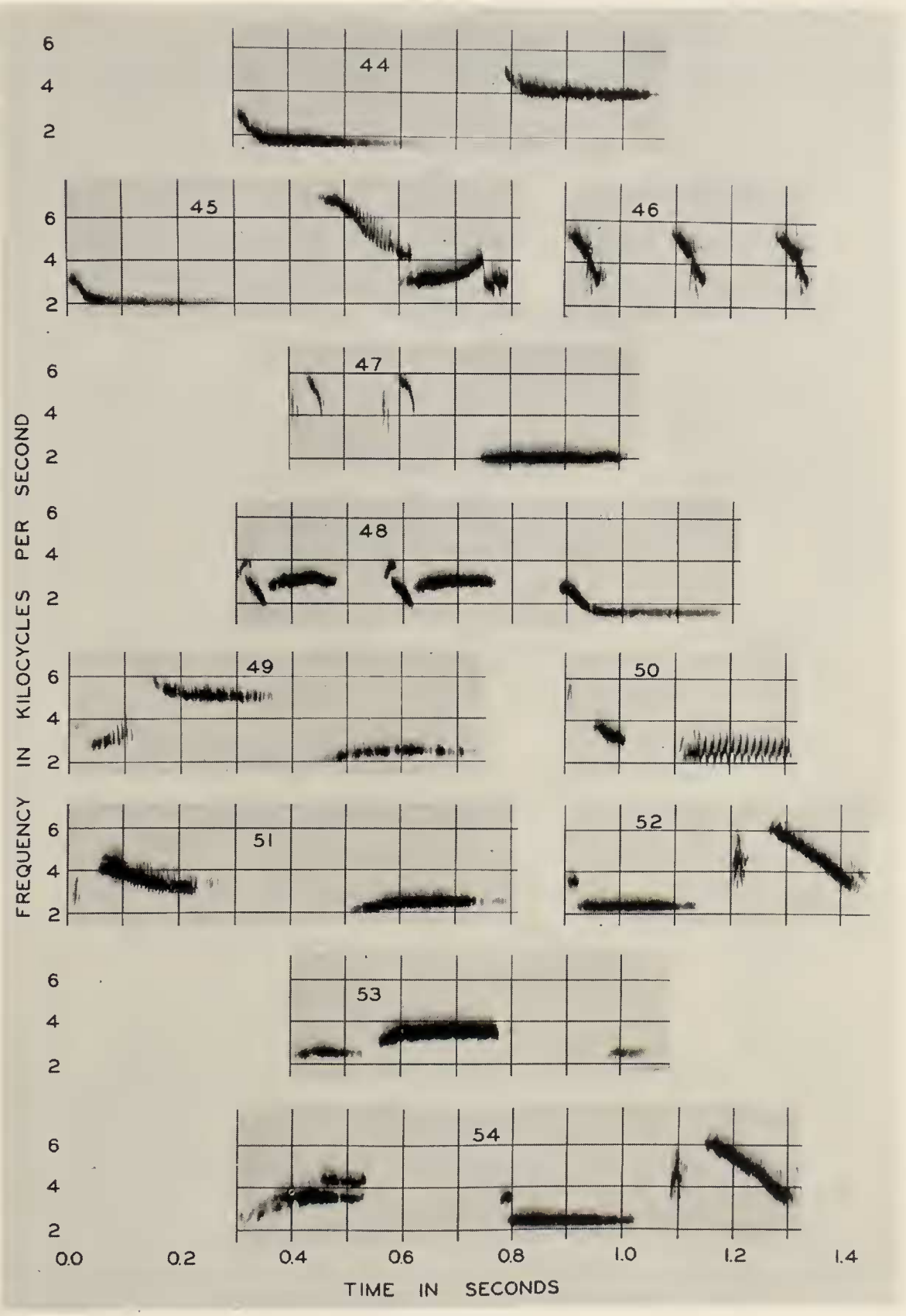
TIME IN SECONDS

PLATE 3.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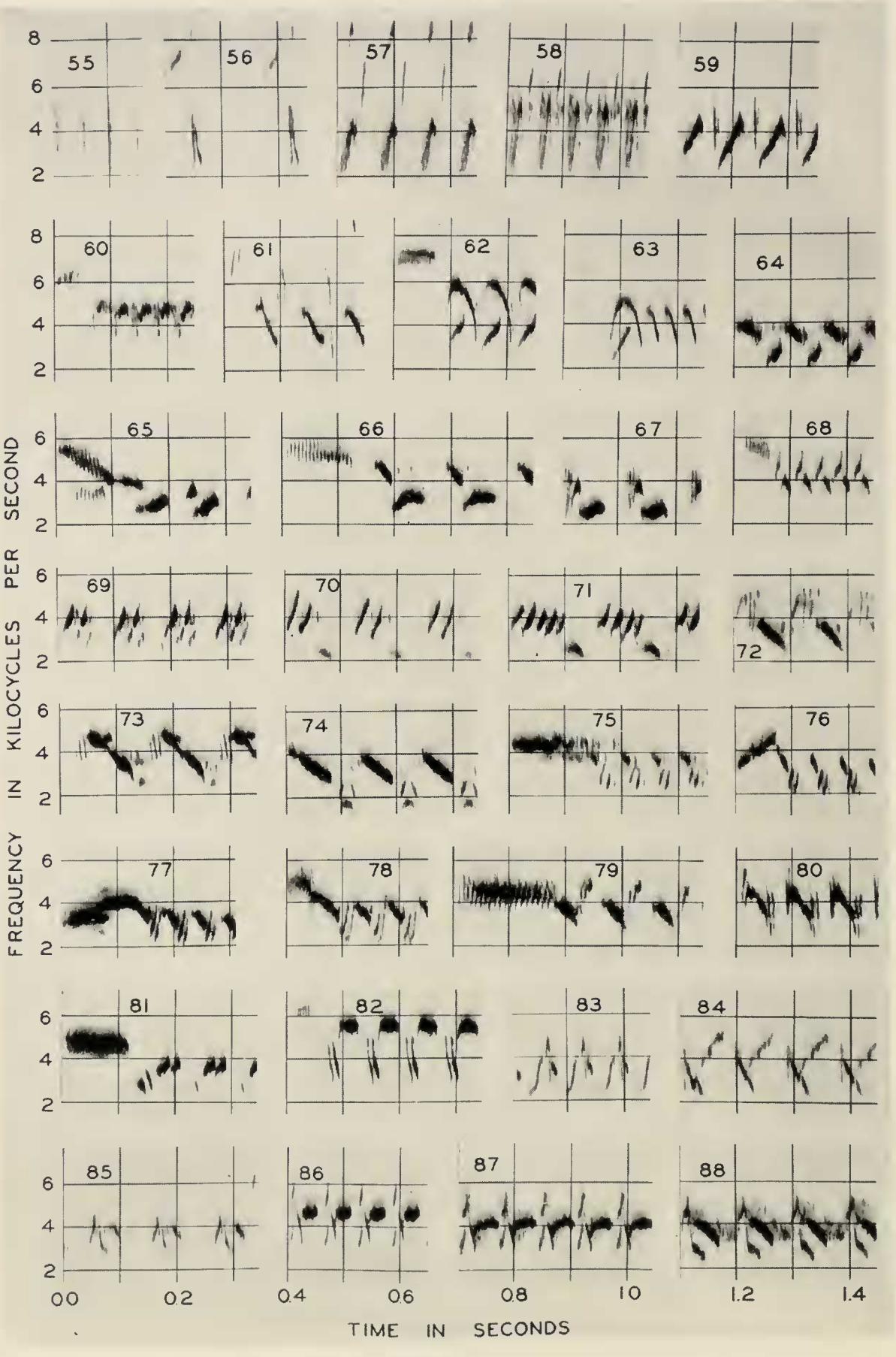
TIME IN SECONDS

PLATE 4.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FREQUENCY IN KILOCYCLES PER SECOND
TIME IN SECONDS
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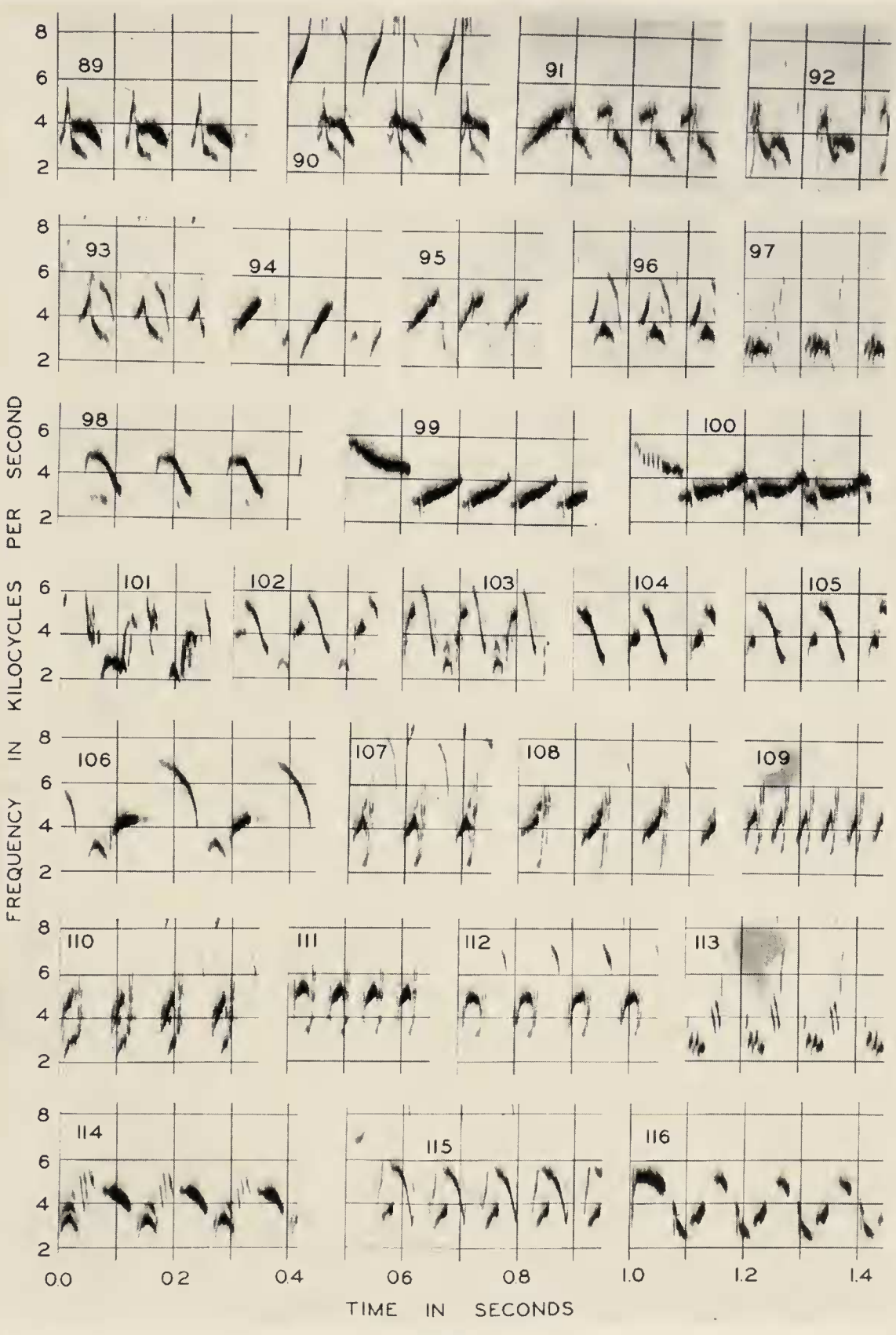
PLATE 5.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FREQUENCY IN KILOCYCLES PER SECOND
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0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
TIME IN SECONDS

PLATE 6.

Literature Cited

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